

# QUESTIONED DOCUMENTS

Forensic Technical Aspects

By

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A thesis

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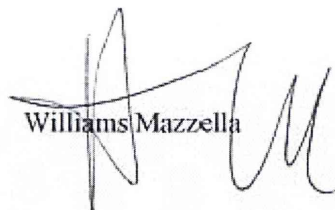
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Lastly, I certify that all the co authors that help me in the preparation of the submitted publications fully agree that I use such published papers to obtain a PhD by publication.

  
Williams Mazzella

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«La vérité est un grand miroir tombé du  
ciel qui s'est brisé en mille morceaux.  
Chacun en possède un tout petit morceau  
et croit détenir toute la vérité.»

Rûmi

"The truth is a large mirror fallen from the  
sky which broke in thousand pieces. Each  
one has a very small piece of it and  
believes to hold all the truth."

Rûmi

# PROLOG

Ordway Hilton (Hilton, 1983) provides the following definition of the word “document”: “In the broadest sense a document is any material containing marks, symbol, or signs that convey meaning or a message to someone”.

Nearly everything we manipulate, touch, and share, is a form of document. In our everyday life we encounter a multitude of printed and/or written documents such as banknotes, credit cards, transport tickets, identity cards, contracts, parking fines, letters and so on. We are born with a document, a birth certificate, and we die with another one, a death certificate. It is easy to understand the importance of documents, even in our digital world. No other instrument of crime is as prevalent in our society as documents. Forged checks, stock fraud, tax fraud, forged or altered wills, welfare fraud, and ultimately identity fraud are a few examples of possible document crimes, some of which may involve billion of dollars.

The most common questioned-document-related crimes involve some kind of falsification, either by forgery or by alteration of a genuine document. Ordinarily, documents are falsified for fraudulent monetary gain but there are other motives. A “suicide” note may be forged to cover up a murder. Identity documents may be falsified in order to conceal a person’s true identity. Documents may be mutilated or destroyed to prevent true facts from coming to light. Examples include someone hiding his or her true identity (e.g. war criminal) or someone claiming the loss of items that never existed (e.g. typical insurance fraud).

Questioned document examination is not limited to handwriting comparison/identification. A document examiner may be called upon to examine a variety of types of physical evidence besides

handwriting. Several types of examinations are sometimes necessary in the comparison of two documents. Any of the following examinations (not exhaustive) may be carried out by a document examiner:

- 1 Examination and comparison between questioned and known genuine documents (typically banknotes and identity documents such as passports, identification cards and driving licenses) and determination of types of writing materials, such as inks, paper, or printing technology, in order to determine if a suspect document can be classified as genuine, as falsified, or as a counterfeit<sup>1</sup>;

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<sup>1</sup> The difference between falsified and counterfeits is that the former is a modified genuine document (for example a genuine passport showing a photo substitution) whereas the latter is a total fake.

- 2 Examination and comparison between questioned and known genuine documents and determination of types of writing materials, such as pens, ink, paper, or printing technology, to establish manufactured or acquired characteristics in order to determine if the suspect and the reference document have a common or a different source;
- 3 Examination of documents to disclose the presence of alterations, erasures, obliterations, or inconsistencies;
- 4 Examination of indented, obliterated and charred writing to try to reconstruct the original writing;
- 5 Determination of the order or sequence in which writing or printing was entered onto a document;
- 6 Determination of the age of writing and/or materials used to “construct” a particular document. The dating approach can be absolute or relative. With absolute dating, the analytical techniques are directed at the determination of a time frame in which a questioned entry was produced; here we are looking for “anachronisms”. With relative dating, samples of two or more questioned areas are analysed and compared to determine which sample is older/younger than the other(s).

As you can imagine, a forensic document examiner embraces a large field of potential analyses. The document examiner has to keep a very close contact with the industry in order to be up-to-date with the latest developments concerning ink, paper and printing technologies and, at the same time, he or she should not forget obsolete technologies (for example mechanical typewriting machine). It is difficult, if not impossible, for a document examiner to be a specialist in every single field of the document examination discipline (i.e. inks, papers, security printing, home office machines, etc.). For these reasons, most of the publications presented in this work deal with documents that I was confronted with during my career as a forensic document examiner. Because the Institut de Police Scientifique (IPS) does not routinely examine identification (ID) documents, such aspects of the document examination discipline will not be treated into this work. The majority of issues that I have been asked to address in my career so far are as follows:

- Determine the possible make and model of a copier, laser printer or inkjet printer that was used to produce a given printed document;
- Establish if two or more documents were printed with the same ink/toner and/or the same printer;

- Verify if a document has been totally written using the same ink;
- Try to enhance a faint inscription or to decipher a latent mark;
- Determine if the alleged date of a document is the true date or not; and
- Verify if a given signature or handwritten entry is genuine or has been forged.

The handwriting and/or signature analysis and identification mostly deal with writer identification and can be considered as one of the rare evidence types that can be defined as direct evidence in the sense that the link between a criminal activity and its author is directly established (for example, in a ransom or threatening letter).

The present thesis is divided into six main parts, as follow:

The **first** part of the thesis will introduce the reader to the world of questioned documents, in particular to analytical methods that are routinely used to analyse paper, ink and toner.

Part **two** will explore ways to improve the detection of latent marks by the use of an ElectroStatic Detector Apparatus (ESDA). The article presented in this section mainly focuses on the effects of the changes of relative humidity and temperature on the detection of latent marks.

The **third** part will introduce the reader to ink analysis. Chapter one will highlight the importance of optical methods. Chapters two and three will focus on the analysis of inkjet printed documents by microspectrophotometry and Raman spectroscopy. Chapters four and five will explore the analysis of a relatively new writing instrument: gel pens. Chapter six will introduce one of the most controversial forensic science topics: ink dating. Chapter 7 will compare two analytical techniques, high performance thin-layer chromatography (HPTLC) and laser desorption ionisation mass spectrometry (LDI-MS), for the differentiation of blue ballpoint pen inks.

Part **four** is dedicated to the analysis of toner. Chapters one and two will discuss the classification and identification of black photocopying toners by diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS). Chapter three discusses a simple combined technique (pyrolysis gas chromatography and diffuse reflectance infrared Fourier transform spectroscopy) for the analysis of toners and adhesives, while chapter four will present a study undertaken to examine and critically compare three measurement techniques for the analysis of photocopy



toners by infrared micro spectrometry and diffuse reflectance infrared Fourier transform spectrometry. The last chapter of part four describes a computer database that can be used to identify a particular model (or group of models) of colour photocopier that may have been used to produce a forged or counterfeit document.

Part **five** will attempt to introduce a Bayesian approach into the questioned document discipline via the interpretation of handwriting and photocopy identification. Chapter one discusses a hypothetical case while Chapter two will illustrate a real case report where the core of the examination involved two envelopes.

Part **six**, the last section of the thesis, will focus on handwriting analysis, particularly the quantification of the shape of the capital letter "O". This paper is a first step towards the objective analysis of handwritten entries.

Applying fundamental forensic science principles, this work should allow the reader to understand questioned document analysis from the general to the particular and from the application of non-destructive techniques to "semi-destructive" techniques. Questioned document examiners need to maintain an awareness of all new developments in physical and chemical methods relevant to the discipline.

It is not an easy task to conceive a general discussion on the basis of different articles that have previously been presented and discussed in isolation. As a general guide, the reader should retain the following points, common to all of the papers published:

- Every forensic document examiner should continue to expand and improve his or her own knowledge.
- Techniques not specifically developed for the questioned document field should be embraced if they add value to an examination. This has been particularly true for the application of forensic light sources such as the Polilight, Crimescope, etc., to the optical examination of documents, particularly inks and papers.
- Understand and improve basic methods such as the Electrostatic Detector Apparatus (ESDA) which allows the examiner to develop latent evidence of better quality.

- When using traditional and new analytical methods, think about and carefully analyse the possible influence of the paper substrate.
- Calibrate each method with standardized samples and verify the forensic results using preliminary blind tests<sup>2</sup>.
- Try to develop methods that are robust; i.e. reproducible with respect to different examiners, and stable with time. For example, toner samples from photocopies produced over an extended period of time on the same machine give identical infrared spectra. This is true, of course, only if the recommended toner is continually used in a particular machine. This is also valid for the pigments analysed by Raman spectroscopy.
- From a practical point of view, a forensic scientist should develop a method that is globally applicable to a particular field of analysis. Binder analysis by FTIR is a good example. In fact, infrared spectroscopy can be generally applied to all kinds of printed toners (photocopiers, laser printers, fax machines, and all-in-one systems).
- Be critical; first of all with yourself and secondly with the published literature. This is particularly true for ink dating publications. Many authors claim the success of their techniques without submitting them to an independent scientific study. Regarding ink dating, I believe that a neutral international committee should be set up with the aim to verify the ink dating studies. I am not saying that our publication is the only one that is valid; at the very least, it is the first one that tries to explain the physico-chemical behaviour of the solvents, principally the phenoxyethanol. If the detection limits for the solvent analysis are significantly improved, reliable and accurate ink dating may become a reality in the future. In this area, the work of Bügler et al. (Büglér, 2006) appears promising.
- New techniques need to be compared with existing techniques in terms of sample discrimination, quality, speed, reproducibility, destructiveness, and cost.

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<sup>2</sup> It should be noted that I was one of the first authors in the question document area to introduce blind tests in my own publications.



- Last but not least, the best strategy for samples differentiation needs to be developed. Forensic document examiners are often confronted with mass-produced items and the principle of identification is at the crux of most questioned document examinations. Relevant principles are discussed below.

Kirk, one of the pioneers in criminalistics, already noted that scientific progress in the field of forensic sciences was more technical than fundamental, applied more than theoretical, and finally more evanescent than stable and permanent. As such, Kirk asserted (Kirk, 1963) that:

*"...Document examiners constantly identify handwriting, but a class of beginners studying under these same persons, would find it difficult indeed to distinguish the basic principles used."*

Although this quotation refers to handwriting identification, this comment is also true for document examination in a wider sense as well as for forensic science in general. Criminalistics should aim towards the following fundamental principles:

- identification;
- individualization of objects or persons; and
- reconstruction.

Before discussing the concepts of individualization and reconstruction, let us briefly address the term of identity or identification.

The term "identity" is described by most authors as something unique (Kwan, 1977). An object can be exclusively identical to itself, because every object in the universe is unique. It is, however, necessary to underline that the term "identification" presents different semantic facets depending on the scientific discipline. For example, in chemistry the term identification refers to a specific organic or inorganic compound, in biology it may refer to a species, etc. Also, in questioned documents, the type of identification depends on the question that is trying to be answered. For example, in an anonymous letter case, the judge may ask us the following questions:

Q-1. Is the handwritten letter an original document or a copy?

*R-1. It is a reproduction.*

Q-2. What type of reproduction?

*R-2. It was produced using an inkjet printer.*

Q-3. What brand of inkjet printer?

*R-4. An Epson.*

Etc. ...

It is evident, even for a neophyte, that in every type of identification ("original or copy", "type of copy", "brand and model", etc.) identification tightens towards the uniqueness and consequently towards individualisation. It is a question, in the above-mentioned case, of a restrictive process that at every stage or answer reduces the size of the printing systems susceptible to be at the origin of the anonymous letter.

Further, we are going to discuss difficulties associated with the reduction process, including the ultimate aim to decrease it to a single object. One should admit that the wish of every forensic document examiner is to be able to give conclusions such as "the anonymous letter was printed with the inkjet printer Epson S80 jet, serial number 98987".

The term "identification" assumes a quite particular sense in forensic science and practitioners have to deviate from other scientific disciplines (sometimes called "exact sciences") because identifying a printed line as being a black ink containing, among others, methyl violet or identifying it as BIC® ink are two very different conclusions.

In 1983, De Forest and co-workers (De Forest et al., 1983) made a fundamental distinction between classic scientific disciplines and forensic sciences. The criminalist must be capable of recognizing, before identifying, the type of evidence with which he or she will be confronted. The criminalist should then decide which technique he or she is going to use and to estimate the relevant information that is useable in the circumstances of the case. Another fundamental element is that exhibits to be analysed always have a particular history and often the expert knows little or nothing about the conditions to which they were subjected.

The same authors describe the principle of identification followed by that of individualization. Identification can be summarized as a sort of classification; every object can be classified in a more or less precise category. In the field of documents, we can have categories concerning the types of writing instruments or the types of printing systems, etc. It is at this level that the notion of "class" or "class characteristics" is often applied. Class characteristics are common to all the objects belonging to the same class. For example, all the electronic typewriters equipped with a Brougham 10 daisy wheel will have the same class characteristics such as font type design as well as character spacing.

Champod (Champod, 2000) prefers to speak about characteristics of manufacture, in the sense that all the objects resulting from a particular batch X will share the same characteristics. It is necessary to underline here that one refers to an industrial production of numerous exemplars and not to hand-made objects that are already unique before being used.

Individualization intervenes when we can demonstrate that every object belonging to a defined class can be distinguished from the others on the basis of "individual characteristics", provided that these exist. Individual characteristics are also described as acquired characteristics (Champod, 2000). This second definition is more elegant because it implies the notion of time. Indeed, time and usage of a certain object can lead to unique accidental deformations allowing for the object's individualization. This means that, in our example concerning Brougham 10 daisy wheels, every character can be randomly damaged in a certain position producing an individual acquired defect.

Le Petit Robert defines (Le Petit Robert, 1990) identification as the action to identify. The term identify pulls its origin from the Latin "idem": meaning the same or "identical". This last adjective is applied to objects or beings perfectly similar, while remaining different.

This last definition may leave us stunned: "...similar... but different". How is it possible that something can be at the same moment similar but different? Does this refer to one object that broke into several different fragments but where global identity is unique, or does it refer to a sample issued from an industrial production and so is defined by class characteristics common to the other objects coming from the same manufacturing batch?

In the first case, we are confronted, for example, with a torn sheet of paper represented by five different fragments which can be put together to reconstitute the original sheet of paper. A

typical example for the second case is a factory of ball-point pens where million of ink cartridges contain the same ink. The pens are all similar, but we are still talking about different pens.

According to Tuthill (Tuthill, 1994), two principles steer our capacity to individualize the elements of proof:

- 1) The principle of uniqueness: All the objects in the universe are unique. Unique correspondence is almost a natural law and not an anomaly. Our failure in the perception of the uniqueness is due to the limitations of our analytical methods.
- 2) The principle of individualization: individualization is defined as the agreement of a large number of individual and significant characteristics as well as the absence of the inexplicable differences which would exclude agreement by pure coincidence.

### **The identity of the source**

The forensic document examiner is often confronted with ultimate questions such as “where did it come from?”, and “who is the author?”, rather than “what is it?” It is often a question of identifying the source or the origin of an ink, a toner, or a printing system.

To trace back the source or the known origin for an object, it is necessary first of all to define the various relationships that exist between the object and the source. Here we shall consider four types of relations as stated by Kwan (Kwan, 1977):

#### **1. Production**

The source can be represented as the raw material from which an object is produced. In the case of ink, there are several ink manufacturers who, in turn, buy raw materials from chemical multinationals.



## 2. Being a part of a whole

The source is a whole and the object is only a fragment, i.e. the object constitutes part of a whole. An example is a container of juice which is opened by tearing; a torn extremity falls in the jacket of a criminal who drinks at the scene of a burglary. The forensic document examiner can associate the torn extremity to the container of juice found at the scene through physical fit.

## 3. Change

The source is a process that changes or modifies an object. A paper sheet issued from a laser printer (even in the absence of any printing) is imparted with physical marks coming from the rolling and grabbing mechanisms. Laser printers can be said to be a source of alteration of paper sheets and these mechanical marks can be highlighted by an Electrostatic Detector Apparatus (ESDA).

## 4. Spatial place

The source of an object is defined as its geographic or spatial origin. The analysis of the header of a fax can give some indications about the sender or the sending location.

### **The level of the source**

There are essentially two levels of source:

1. The source indicated as a class of entities,
2. The source defined as an individual and unique entity.

In the lexicon of the specialist in criminal law (Kwan, 1977), the determination of the source of an object as belonging to a class is known under the term of identification. Identification distinguishes itself from the term "identity" by the fact that the first consists of an operation and second is characterized by a relation (ibidem above). The process of identification is a classification where it is sufficient to establish, in a general sense, where an object belongs to a

class or to a particular category. For example, that the toner used to print the anonymous letter is of single component type, i.e. constituted with material containing iron.

On the other hand, the identity of an object is the relation which determines that an object belongs to a unique entity; it is about the process of individualization. The individualization of the toner of the anonymous letter would consist of identifying the unique electro-photographic system at the origin of that letter.

It is evident that the relationship between identification and individualization is situated at the level of the degree of the source being sought. As mentioned by Kirk (1963), identification is a prelude to individualization as it can be seen as a narrowing-down process. It is interesting to note that definition and level of source are different for every case and depend on the circumstances of the case.

### **Problems in the definition of the source**

Several problems arise during the genesis of the source of an object; in summary, we can restrict them, as far as the domain of the expertise of documents, to the interchange of sources, concurrent sources and to the continuum of sources.

#### **The interchange of sources**

An exchange of sources can culminate in the realistic problem of a false conclusion. It is notorious that the same manufacturer of home office machines sells products under different names. For example, colour photocopiers of the brand Ricoh are also sold under the names Gestetner, Nashua, Infotec, Lanier and Rex Rotary. A lack of market knowledge and understanding can lead to errors; for example, identifying a toner as resulting from the source Ricoh may generate inaccurate investigative leads if the suspect copier is of brand Nashua.

#### **The concurrent sources**

The problem of concurrent sources is exemplified by the crossing of two homogeneous black lines from felt-tip pens (aqueous liquid ink). The forensic document examiner may need to

determine the order of deposition of the two lines. It is evident that, in this case, the two inks will penetrate one into the other leaving the question without an accurate answer.

#### The continuum of sources

Differentiation of similar sources in all their properties is a problem well known in criminalistics. Indeed, it is practically impossible to chemically distinguish two toners stemming from the same production batch. The results of the physico-chemical analysis of the toner of two printed documents, A and B, arising from two identical laser printers, x and y (same brand and model), will be the same. The expert will not be able to say if document A was printed with the printer x or y, based only on the chemical analysis of the toner. This will also be true for document B.

#### Where to from here?

As a forensic document examiner, the ultimate question may be: Is it possible to conclude that the inkjet printer seized from the house of Mr. X was used to print the anonymous letter? In the absence of acquired defects, the answer is clearly “no”. All the analytical techniques developed in this work allow classifying a sample into a specific group according to its characteristics. Because the different types of evidence associated with a document are often mass produced (e.g. inks, toners and printing systems, etc), even the rarest class (the class containing only one brand and model) incorporate many thousands of samples. So the reduction to a single item cannot be reached solely on the basis of analytical techniques. These latter processes are most useful when the samples of interest can be differentiated. Then the document examiner can conclude that they are from different sources. When the analytical techniques show no differences, we may use such information as supportive evidence and strongly depend on the circumstantial information's.

We tend to use more and more techniques to show that two samples cannot be differentiated yet the strength to our conclusion does not change (eg. sample “A” could have come from the same source as sample “B”). Our techniques are getting more sophisticated, but the results interpretation step has not really progressed to take this into account.

The time is coming to ask the right questions, eg. how many laser printers of same brand and model are made?, where they are distributed?, etc. This kind of information, associated to the non-differentiation by the analytical results may lead to strengthen our conclusion. This is obviously where Bayesian statistics can help but we are still a long way off being able to apply such an approach in routine casework.

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